REMARKS

Applicants have amended their claims in order to further define various aspects of the present invention. Specifically, Applicants are adding new claims 12-14 to the application. Claim 12, dependent on claim 4, further defines the number of carbon atoms in the oxyalkylene groups. Claim 13, dependent on claim 4, further defines the molar ratio between the compound of (formula 2) and the compound of (formula 3); and claim 14, dependent on claim 8, defines a molar ratio of the number of moles of the electrolytic salt to the total number of moles of the ether oxygen atoms in the oxyalkylene groups.

In connection with the newly added claims, note, for example, pages 5, 8 and 12 of Applicants' specification.

The restriction requirement as set forth in Items 1-5 on pages 2 and 3 of the Office Action mailed August 17, 2006, is noted. Applicants affirm their election of the Group II claims, that is, claims 4-9 and 11. Newly added claims 12-14 also fall within the Group II claims and are to be considered on the merits in the present application. Applicants do not further traverse this restriction requirement.

Applicants respectfully traverse the rejections of the claims being considered on the merits in the Office Action mailed August 17, 2006, and respectfully submit that all claims presently being considered on the merits in the above-identified application patentably distinguish over the teachings of the prior art applied by the Examiner in rejecting claims in the Office Action mailed August 17, 2006, that is, the teachings of International (PCT) Published Application No. WO 01/39316 (U.S. Patent No. 6,833,220) to Yokoyama, et al., and European Patent Specification No. 1,160,268 to Nishiura, et al., under the requirements of 35 USC 102 and 35 USC 103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such polymerizable composition for an electrochemical device as in the present claims, including, inter alia, wherein such composition comprises the boron-containing compound represented by the formula 2 and the boron-containing compound represented by the formula 3, wherein the molar ratio between the compound of formula 2 and the compound of formula 3 is 0.1-9, and wherein an average number of moles of the oxyalkylene group(s) added is less than 4 and more than 0, provided that each of the sum of p+q+r and the sum of α+β+γ is 1 or more. See claim 4.

In addition, it is respectfully submitted that the applied references would have neither taught nor would have suggested such polymerizable composition, including the boron-containing compounds represented respectively by formula 2 and formula 3, wherein such molar ratio between the compound of formula 2 and the compound of formula 3 is 0.1-4, and wherein an average number of moles of the oxyalkylene group(s) added is less than 4 and more than 0, provided that each of the sum of p+q+r and the sum of α+β+γ is 1 or more. See claim 5.

Furthermore, it is respectfully submitted that the teachings of these applied references would have neither disclosed nor would have suggested such polymerizable composition, or an ion-conductive polyelectrolyte for an electrochemical device which includes a polymer obtained by polymerizing this polymerizable composition (see claims 6 and 7); and would have neither taught nor would have suggested such composition or such polyelectrolyte wherein the polyelectrolyte also includes at least one electrolytic salt (see claims 8 and 9); and/or wherein the electrolytic salt is selected from the specific group set forth in claim 11;

and/or wherein the oxyalkylene groups of the polymerizable composition have 2-4 carbon atoms (see claim 12); and/or wherein the molar ratio between the compound of formula 2 and the compound of formula 3 is 0.5-4 (see claim 13); and/or wherein a molar ratio of the number of moles of the electrolytic salt to the total number of moles of ether oxygen atoms in the oxyalkylene groups is in a range of 0.0001-1 (see claim 14).

The present invention is directed to a polymerizable composition useful, e.g., as an electrolyte for electrochemical devices, as well as an ion-conductive polyelectrolyte provided utilizing a polymer formed from such polymerizable composition.

As described in Applicants' specification, secondary batteries using a solid electrolyte such as an inorganic crystalline material, inorganic glass, organic polymer or the like have recently been proposed. Organic polymers are expected to be developed, for example, because, in general, they are excellent in processability and moldability, give an electrolyte having flexibility and processability in bending, and improve the degree of freedom of design of a device obtained by the use thereof.

However, organic polymers are inferior to other materials in ion-conductive properties.

Various techniques have been proposed for providing organic polymers for use in electrochemical devices. For example, a material obtained by incorporating a poly(ethylene oxide) with a specific alkali metal salt, has been proposed. It has also been proposed to use a copolymer of a boron-containing polymerizable monomer and another polymerizable monomer. However, these proposed polyelectrolytes are not satisfactory in ionic conductivity value required, e.g., of an electrolyte for a lithium ion secondary battery.

Against this background, Applicants provide a polymerizable composition both that is safe and has high ionic conductivity. Applicants have found that a polymerizable composition as in the present claims, having the boron-containing compounds of formula 2 and of formula 3, with the molar ratio between the compound of formula 2 and the compound of formula 3, and with the composition having a relatively small number of oxyalkylene groups, achieves objectives of the present invention; and, in particular, a polymer obtained by polymerization of the polymerizable composition can be utilized as a polyelectrolyte excellent in safety and with a high ionic conductivity.

As described in the last full paragraph on page 4 of Applicants' specification, when an ion-conducting polyelectrolyte comprising a polymer obtained by polymerizing a composition within the scope of the present claims is used, the number of moles of the added oxyalkylene groups is small, so that lithium ions coordinating with the ether oxygen(s) can easily move, resulting in a high ionic conductivity.

As to the molar ratio between the compound of formula 2 and the compound of formula 3, by providing a molar ratio as in the present claims, deterioration of flexibility of the formed polymer is avoided, so that difficulty in shaping of an electrolyte membrane can be avoided. Moreover, by having a maximum value of the molar ratio that is 9, a decrease in mechanical strength, and difficulty in formation of the solid polyelectrolyte, is avoided. Furthermore, with a maximum of the molar ratio of 4 (see claims 5 and 13), a decrease in mechanical strength, resulting in difficult handling, can be avoided. Note the last full paragraph on page 8 of Applicants' specification. See also the paragraph bridging pages 8 and 9 of Applicants' specification.

Nishiura, et al. discloses ion-conductive polymeric compounds, a polymeric electrolyte and an electric device using the same. This patent document discloses that in the ion-conductive polymeric compound, one or more trivalent boron atoms are present in the polymeric structure. See paragraph [0008] on page 2 of this patent document. In paragraphs [0023]-[0028] on page 4 of this European patent document, a second ion-conductive polymeric compound is described, obtained by polymerizing a mixture of compounds represented by the general formulas (9) and (10) in paragraph [0024]. In paragraph [0032] on page 7, Z in general formula (10) is defined as representing a residue of an active hydrogen compound, examples of the active hydrogen compound including ethylene glycol, glycerin, trimethylolethane, diglycerin and pentaerythritol. Note also paragraphs [0008]-[0010] on page 2, and paragraph [0018] on page 3, of this European patent document. The European patent document discloses that the mixing ratio of the compounds of formula (9) and formula (10) is 1/99-99/1, preferably 10/90-90/10, in terms of a weight ratio. See paragraph [0026] on page 4 of this European patent document.

It is respectfully submitted that this European patent document would have neither taught nor would have suggested such polymerizable composition as in the present claims, including both the boron-containing compound represented by formula 2 and the boron-containing compound represented by formula 3, or the molar ratio between these compounds, or the number of moles of the added oxyalkylene groups and advantages of the present invention due thereto.

The contention by the Examiner in the first paragraph on page 5 of the Office Action mailed August 17, 2006, that the formulas (9) and (10) of the applied European patent application are substantially identical to the claimed formulas (2) and (3), is respectfully traversed. It is respectfully submitted that the formula (10) of

the applied European patent application contains no boron atom but contains polymerizable functional groups; and it is respectfully submitted that such compound would have neither disclosed nor would have suggested the boron-containing compound of formula 3 of the present claims.

Since the compound of formula 10 in the applied European patent application contains no boron atom, it is respectfully submitted that sufficient ion conductivity cannot be obtained, due to the small amount of boron atoms in the polymeric compound.

In addition, it is respectfully submitted that the compounds of formulas (9) and (10) in the applied European patent application, which both contain polymerizable functional groups, which increases elasticity and causes hardening with enhancement of crosslinking density. Furthermore, the average number of moles of the oxyalkylene groups added is substantially 4.8 or more in the applied European patent application, so that mobility of the polymer chain is poor. As a result, it is respectfully submitted that ion conductivity of the material in the applied European patent application is low.

Accordingly, it is respectfully submitted that the material disclosed in the European patent application fails to obtain objectives achieved by the present invention, that is, enhancement of ion conductivity attained by use of the compound of formula 2 containing boron atoms and a polymerizable functional group, and the compound of formula 3 containing boron atoms without polymerizable functional groups, and wherein the average number of moles of the oxyalkylene groups added is less than 4 and more than 0 (note claims 4 and 5).

With respect to the average number of moles of oxyalkylene groups, attention is respectfully directed to Comparative Example 2 described on pages 52 and 53 of

Applicants' specification, with results in connection therewith being shown in Table 2 on page 54 of Applicants' specification. As to components of materials in Comparative Example 2, note the continuation of Table 1 on page 15 of Applicants' specification. Note that Comparative Example 2 evaluates a polyelectrolyte having an average number of moles of oxyalkylene groups being not less than 4. That is, Comparative Example 2 uses a polymerizable boron-containing compound J (average number of moles of oxyalkylene being 8) and the boron-containing compound K having no polymerizable group (average number of moles of oxyalkylene group being 11.8). The molar ratio of the compound J to compound K is 0.79 (formula 2):1 (formula 3), within the scope of the molar ratio in claims 4 and 5. However, these compounds in Comparative Example 2 have an average number of moles of oxyalkylene groups which is outside the presently claimed range, and note that the resulting material is inferior to the present invention in ionic conductivity.

It is respectfully submitted that this Comparative Example 2 shows unexpectedly better results achieved according to the present invention having an average number of moles of the oxyalkylene groups as in the present claims, supporting a conclusion of unobviousness of the present invention.

Yokoyama, et al. discloses an electrolyte for secondary batteries which is a polymer electrolyte, and a secondary battery comprising such an electrolyte. The electrolyte is defined, inter alia, in (d) at column 2, line 50, though column 3, line 8, of this patent. That is, the electrolyte includes, inter alia, an organic polymer compound which includes a polymerization product of a compound represented by the general formula (2) at column 2, line 60, or a polymerization product of a boric acid ester compound obtained by the esterification of the compound represented by the general formula (2) with boric acid or boric anhydride. See also column 7, lines 52-

54, disclosing that the compounds represented by the general formula (2) or (4) may be used singly or in combination of two or more thereof; and note also column 10, lines 58-65, disclosing that the polymerization product of boric acid ester compound or nitride group-containing compound derived from the general formula (2) is preferably used in admixture with the polymerization product of the compound represented by the general formula (4) and the organic polymer compound represented by the general formula (6) for the purpose of providing good mechanical properties. See also column 2, lines 20-38 of Yokoyama, et al.

Attention is respectfully directed to the compound represented by the general formula (2) esterified with boric acid or boric anhydride in providing the polymerization product for forming the electrolyte in Yokoyama, et al. It is respectfully submitted that such compound or such polymerization product in Yokoyama, et al. would have neither taught nor would have suggested the compounds of formula 2 or of formula 3 as in the present claims, much less the average number of moles of the oxyalkylene groups or molar ratio between compounds of formula 2 and of formula 3; and/or advantages achieved through use of the compounds and amounts thereof, as in the present claims.

In addition, it is respectfully submitted that all of the boron compound molecules in Yokoyama, et al. have polymerizable functional groups, so that crosslinking density of the resulting polymer compound becomes high and its elastic modulus is high. In contrast, according to the present invention the compound of formula 3 contains a boron atom without polymerizable functional group. It is respectfully submitted that Yokoyama, et al. would have neither taught nor would have suggested the polymerizable compound as in the present claims, including the compounds respectively of formula 2 and of formula 3.

Furthermore, it is respectfully submitted that in Yokoyama, et al., molecular weight of the oxyalkylene chain is at least 150, such that the resulting polymeric compound has poor mobility. Consequently, it is respectfully submitted that ion conductivity of the polymeric compound in Yokoyama, et al. is unsatisfactorily low.

It is respectfully submitted that Yokoyama, et al. would have neither taught nor would have suggested the presently claimed composition or polyelectrolyte formed using such composition, including the specified compounds and molar ratio therebetween and average number of moles of oxyalkylene groups as in the present claims, and advantages achieved thereby, including, inter alia, enhancement of ion conductivity while attaining a safe polyelectrolyte.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently in the application are respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (case No. 500.43280X00) and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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